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[The following are translations of selected articles in the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

Air Force Commander-in-Chief Interviewed on Training, Other Issues

91SV0014A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 2-3

[Interview with Yevgeniy Ivanovich Shaposhnikov under the rubric "Combat Training—Quality and Efficiency!": "Results and Prospects"]

[Text] *The training year has ended, and its results have been summarized. What were they for the air force? What awaits the combat fliers in the near future? Will a way out of the crisis the whole country is in be found? The commander-in-chief of the air force, Col Gen Avn Yevgeniy Ivanovich Shaposhnikov, answers these and other topical questions.*

[Question] Comrade commander-in-chief, you set forth the views of the command on the state of affairs in the air force and the conceptual framework for its development to the year 2000 in the August issue of our journal for last year. Events have developed so rapidly, however, that a great deal has changed since then. How would you describe, in general terms, the situation in which the military collectives have had to work?

[Shaposhnikov] Yes, the processes that are transpiring in the country and the world have not passed the army by either. The realization of the new military policy of the Soviet state is gathering speed. Our and the American short-range missiles have been destroyed, the elimination of intermediate-range ones is continuing, the provisions of a treaty for mutual reductions of 50 percent in strategic offensive arms are being worked out and agreement has been reached on conventional weapons on the European continent. The withdrawal of our troops from the countries of Eastern Europe and Mongolia is also continuing as well.

The progressive processes in society are not transpiring easily, and the desperate resistance and perimeter defense of the conservative forces is having an effect. The fight for power and the political discord within the state have engendered confrontation among various groupings, ethnic and extremist sentiments etc. All of this is naturally affecting the morale of the servicemen, forcing us to seek non-standard approaches to training and teaching the fliers.

The command, as they say, has plenty to rack its brains over. It is no secret that the execution of combat training in aviation units is being made more complicated, even when they are fully equipped with combat aircraft, by a surplus of flight personnel and a shortage of engineering and technical personnel. The functioning of the already under-developed army infrastructure is aggravated by the imbalance in the state mechanism of economic operation.

[Question] Combat training has been and is being conducted intensively nonetheless. There are probably certain successes as well?

[Shaposhnikov] Naturally. Duty is duty. Despite the complex situation in the country, the resolution of the tasks connected with combat and mobilization readiness and the assurance of flight safety are being implemented in accordance with the plan. Command and staff exercises have been widely conducted, at which we have learned the fulfillment of combat missions and the control of subordinate units in the first defensive operations.

The repulse of a mass strike, withdrawal from aircraft from under it, fighting stealth aircraft, the mass application of electronic-warfare equipment and the like were all practiced. Much attention was devoted to ensuring flight safety.

Our efforts aimed at reducing the accident rate in flight operations are nonetheless not always having the results that we predict. The lack of everyday amenities for the fliers, the cutbacks in flying time, morale, psychological tension and peoples' lack of confidence in tomorrow all had, and are having, an effect. There were several dozen flight accidents last year as a result. Sixty percent of them occurred the with equipment in good working order. That is, practice has demonstrated to us once more that flight safety cannot be radically increased without solving a whole set of problems connected with the life and activity of the personnel.

The aviation engineering service has performed an enormous amount of work, including connected with the redeployment of aircraft. Despite the complexity of modern aircraft technology and its quite frequent breakdowns today, the engineers and technicians have maintained no less than 90 percent of the aircraft in working order. It was not easy to achieve such high indicators in the face of a total shortage of all and everything, starting with a shortage of specialists and ending with the lack of spare parts.

[Question] And what does not satisfy you, as the commander-in-chief, in the organization of military affairs?

[Shaposhnikov] It would probably be simpler and quicker to list what satisfies me—so many problems have accumulated. The state of military discipline is alarming. A series of crimes by servicemen have provoked a short-sighted policy by the governments of some of the union republics. The appeals to soldiers to return to their homelands have had an effect—the number of deserters has increased. The outburst of crime in civilian life has produced an outburst of crime among us as well—it has increased by 20 percent. Cases of non-regulation mutual relations have increased by 23 percent, and theft by 22 percent. Several hundred people were killed or maimed over the year. This is less than the prior year, but can we really talk about norms when the discussion concerns people?

I want to emphasize one important aspect. The governments of the individual union republics are actively taking a hand in disrupting the next regular induction of the youth for active military service. The shortfall of soldiers is making itself felt in the units as a result. We are thus efficiently resolving the question of assigning people serving in the Soviet Army to vacant posts.

Matters have not improved at the higher educational institutions of the air force—the levels of military discipline and flight safety have not risen.

Mistakes in the activity of the air force rear services have also made themselves felt. It is enough to say that up to 300 aircraft and helicopters are idle each day due to late deliveries of spare parts and assemblies. And that is at a time when every hour of flying time is worth its weight in gold, as they say.

[Question] Comrade commander-in-chief, some of our readers are asking whether it is worth keeping combat readiness at the assigned level at the same time as international relations are warming up, with such upheaval, with such colossal tension of physical and moral forces? Perhaps we should seize the moment and reduce the level of requirements, taking this difficult stage at the fast march rather than at the run?

[Shaposhnikov] Such statements are well known to me. Yes, the burdens on the personnel are great. Yes, the people have gotten tired of waiting for improvements in all spheres of their lives and activity. You think that I, as the commander-in-chief, do not want my subordinates do have a regulation work day, two guaranteed days off etc.? But we have no opportunity as yet of reducing the intensity of combat training. And here is why.

In assessing military confrontation we should proceed not from the political intentions of the sides, which could change rapidly, but rather chiefly from their military capabilities as the most stable factor in the changed political climate. We will address the actual facts.

The armed forces of the United States and the other NATO countries remain the largest in the world. The number of their bases and military facilities around the USSR has not decreased. The United States has not as yet canceled a single development program for future weapons—the SDI and space weapons, third-generation nuclear weapons, aircraft using Stealth technology and weapons based on new principles of physics. The attempts to pull away from us in the development of high-precision weaponry are evident. Who can guarantee that territorial claims will not be made against the USSR in the foreseeable future? The war in the Persian Gulf is also making the situation more acute, while the military might of Japan and South Korea is growing. In the new Europe we more and more often have to compare the overall correlation of forces between NATO and the USSR, rather than NATO and the Warsaw Pact. And it is far from being in our favor after the realization of the treaty on conventional weapons in Europe. The correlation of attack helicopters and combat aircraft of the USSR and NATO in particular will be equal to 1:1.3, or 1:2 according to quantitative and qualitative parameters. That's the arithmetic...

[Question] In other words, we are faced with the necessity of re-orienting combat training toward qualitative parameters. What ways of realizing it does the air force command see under conditions of a decrease in the number of air units and aircraft, a surplus of flight personnel and cutbacks in flying time?

[Shaposhnikov] We have been able to keep combat proficiency at an adequate level overall, even though flying time has decreased, thanks to the innovation of commanders on the scene. And the switch from gross flying time to qualitative parameters has helped as well. The focus is on more careful preparation of the aircraft and the pilots for flight and improvements in the techniques for flight training. Not for the fun of it, of course, we are redistributing flying time, limiting the experienced pilots who are flying basically to maintain skilled already attained, in order to give the green light to the young pilots in flight training. I want the officers to understand that these steps are both forced and temporary.

The air force command hopes, and calculations confirm this, that the situation with flight personnel will stabilize by 1993, and only the standard staffing levels will remain in the regiments by 1995. Our main mission is not to repeat the situations that the air force got into in 1960, retain the professionals and provide them with a painless departure to their well-deserved rest with time.

[Question] Comrade commander-in-chief, how would you describe, in general terms, the tasks facing the air force in the new training year?

[Shaposhnikov] We have already mentioned them in our conversation in one way or another. As concerns, say, strategic directions in our military affairs, I feel that the main thing in 1991 is the maintenance of the combat might of the air force at a level that ensures the guaranteed repulse of any aggression. We will have to expand the work on the realization of the principles of Soviet military doctrine, which is founded on the principle of defensive sufficiency. The air force should be ready for reciprocal actions on the territory of the USSR, allowing for the military and political situation and transformation of the Warsaw Pact.

The intensity of training will not be reduced in the coming year, despite the significant complication of the tasks. Work is being strengthened on incorporating the concepts of averting aerial accidents.

The withdrawal of the Central and Southern groups of forces will be completed, and the redeployment of aircraft from Germany and Poland will come up on the agenda. The time frames have already been determined, but they must still be linked with a well thought-out program for transporting the personnel, families, equipment and military matériel. It should be said that this

program is being developed very carefully. Command and staff training is underway, at which possible variations for the redeployment and situations that could arise therein are meticulously modeled. The specific performers are determined. They will be personally responsible for this or that portion of this complex process. We are trying, in other words, to take into account the mistakes that have been made in the past and extract lessons from them.

The proficiency of the flight personnel should be maintained for all types of training. The cohesiveness of combat teams, stable command and control and high combat readiness are the main points of reference for unit commanders. Upon completion of the redeployment, every regiment should be ready, in the shortest possible time, to fulfill its combat missions under the new conditions. The all-round checking of the level of flight proficiency of all flight personnel is planned.

Multiple-variation tactical air exercises are being planned that allow for the possibility of a surprise mass strike by enemy aircraft with attempts to blockade our airfields and gain air supremacy, and the requisite attention will be paid to practicing the withdrawal of aircraft out from under a strike, the application of EW equipment and new methods of fighting stealth aircraft. The more so as their annual replacement rate is 20 percent.

We are putting the chief emphasis in training on independent work by generals and officers, the performance of various types of training simulations, brief operational drills, war games and the development of intelligent initiative, resourcefulness and the ability to take risks. The principle of "teaching the troops what is essential in war" should ultimately be brought to life.

Since army aviation has been transferred to the ground forces, the task of setting up clear-cut interaction with them has come before us. This will moreover demand flight safety, as well as combat readiness.

The higher educational institutions of the air force must be transformed into a school of not just professional training, but accident-free operations as well. It is planned to improve the techniques of flight training for cadets there along with the selection of specialists of all ranks for working with them, as well as developing a uniform ritual for graduation with the academies and making the process of improving the officer continuous in the future, along the lines of school—formation—academy—formation. The time has come to take basic flight training under the wing of the boarding schools, and to make broader use of the capabilities of the DOSAAF schools.

The aviation engineering service, the operation of the air force rear services, the communications and radio support troops and other organizations will all be improved within the framework of military doctrine and the conceptual framework for the development of the air force. We will unfortunately have to postpone the conversion to a base system due to the accelerated withdrawal of our troops from abroad.

[Question] And a concluding question. Your personal views on the prospects for the development of the situation in the country and the future of the air force? What would you wish the fliers in the new training year?

[Shaposhnikov] I am an optimist. I believe that our country will get out of the crisis renewed and ready to flourish. The main thing now is to close ranks, create sturdy aviation collectives, provide for mutual proficiency and support each other. Only in that case will it be possible to oppose the destructive forces and set up creative work.

As for the air force, my opinion is unequivocal here. Our country, with borders more than 60,000 kilometers long, should have mobile armed forces. This condition is not realistic without military aviation. It is no accident that the development programs for combat aviation and space technology are priority ones in the leading countries of the world.

I want to wish all fliers endurance, consideration and sober-mindedness in the making of decisions, and, of course, optimism.

Lack of Pilot Training in Spins Faulted

91SV0014B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 10-11

[Article by Hero of the Soviet Union and Honored Test Pilot Candidate of Technical Sciences A. Shcherbakov with A. Klimov and A. Gorlov, leading specialists of the OKB [Experimental Design Bureau] imeni A.I. Mikoyan, under the rubric "In the Arsenal of the Combat Pilot": "Teach the Spin"]

[Text] The article by Colonel G. Rayevskiy titled "Should the Spin Be Taught?" (AVIATSIYA I KOSMONAVTIKA, 1990, No. 3), which discussed the ban on teaching the spin using the L-39 aircraft to the cadets at flight schools and the negative consequences of that step, basically confirmed our own stance as well. The history of the appearance of this problem is of interest. The attitude toward training critical flight procedures was equivocal at one time. It was founded not only on the subjective views of individual personalities, but also on the concepts for the application of the Air Forces that had taken shape.

In the years when the spin was thoroughly mastered at the service schools, the number of flight accidents due to accidental entry into this mode was relatively small, and the pilots felt confident in dogfights. Before the war, taking into account the rigorous nature of aerobatic

maneuvering in the aircraft of the time, it was mandatory to teach the spin using U-2 and UT-2 aircraft. The course of flight training envisaged its performance in solo flights by cadets using the I-16 combat aircraft as well.

The aircraft of the Great Patriotic War designed by Yakovlev and Lavochkin had even more favorable performance characteristics in the critical modes than the prewar models. The execution of a spin in checks of flying technique using "Yak" and "La" two-seat trainers, however, remained mandatory.

Jet fighters began coming into service at the end of the 1940s. The most widely produced of these, the MiG-15, had no fundamental distinctions from its piston predecessors in pulling out of a stall or a spin. The effects of the aileron position on nature of the rotation, true, was noticed using them, as on the UT-2 and I-16.

All pilots in line units and cadets at the service schools were taught the spin on the MiG-15 jet trainer for a long time, but this was soon banned by order of the Air Forces Commander-in-Chief. This decision was explained by saying that more aircraft were lost in practicing the spin than in the air units operating the new MiG in conventional flights. The authors of this article had access to statistics on the accident rate of series-produced aircraft of this type and tried to find documentary confirmation of the opinion that formed "on high," but without result.

Also interesting is the fact that in 1952, while still a test pilot at the Air Forces NII [Scientific-Research Institute], cosmonaut G. Beregovoy was teaching the spin to the pilots of two military districts, about which a report was then filed. He did not have a single precondition of a flight accident in that time. Other evidence also gives grounds to assert that the assimilation of the spin posed no danger using aircraft with satisfactory characteristics of stability and controllability, although it required special training by instructor personnel. The opinion of the increased accident rate nonetheless became one of the reasons that laid the foundation for a negative attitude toward the mastery of critical flight procedures. The spin training that was subsequently performed at the flight schools, which could be reduced to the execution of a single descending spiral from horizontal flight using the L-39 trainer, could not be taken seriously. But even that is prohibited today.

The negative attitude of the leadership of the Air Forces and air-defense aviation toward having the flight personnel master skills of pulling aircraft out of stalls and spins can be explained partly by the change in the missions of maneuverable aviation at the beginning of the 1960s. The interception and destruction of high-speed and high-altitude targets by missile on the first attack became the principal mission for fighters at that time. Maneuverability thus began to be considered not the chief factor of aerial combat, since there was no need to sustain large G-forces when performing air intercepts. All of the pilots' attention was directed toward ensuring the safety of the flight when operating at supersonic speeds. Such problems as spins receded into the background.

Aerobatic maneuvering skills at the maximum angles of attack, however, became a necessity once again when aerial battle became topical at the end of the 1960s (the consequence of local wars). And today, when the fighter arsenal has been enriched with the maneuvers of dynamic pullout at stalling angles of attack, one variety of which is the "cobra," at near-zero speeds and a number of others, the mastery of skills in aerobatic maneuvering in stalls and dropping into a spin has become a vitally necessary condition for the fighter pilot today. Statistics testify that most flight accidents that are not connected with failures of the equipment itself are caused by errors in piloting and the entry of the aircraft into critical flight modes.

Various passive and active technical devices are used today, of course, to avert a stall. We are convinced, however, that the existing and future systems—which, by the way, restrict the maneuverability of the aircraft to this or that extent—still cannot, and will not be able to, eliminate stalls entirely in the future. Situations sometimes arise when the pilots "overpower" these limitations in flight. Even the use of an automatic spin pullout system on the American F-16 does not solve the problems of averting it.

The mastery of the spin is an obvious fact for the test pilot. But why does a fighter pilot need to master it? The more so as the practical assimilation of this maneuver is an exceedingly debatable matter. There were instances where it was utilized to break off an enemy attack in World War II and later local wars, but the tactical initiative was lost thereby. It is, at the same time, difficult to avoid exceeding the allowable angle of attack both according to the conditions of the precision of the aerobatic maneuvering and according to tactical considerations under the conditions of close-quarters aerial combat. The pilot should be confident that the spin will not pose a danger to him and that he can always pull the craft out of that mode with a sufficient reserve of altitude. If such confidence is lacking, he will hardly be able to utilize the maximum capabilities of the aircraft even with the presence of stall-prevention equipment.

A pilot's ignorance of the typical features of the behavior of the aircraft in a spin moreover frequently leads to the fact that maneuvers with an intense angular spin (a type of deep spiral) are incorrectly perceived as spinning, and an ordinary situation in which an aircraft is entirely controllable is turned into an emergency situation.

The readouts of the flight data recorders illustrating the article by G. Rayevskiy also confirm this; it can be seen from them that the spin is halted after the first release of the stick away from himself from the position $\delta_v = -30°$. The steady increase in the instrument velocity and G-forces, which do not occur in this mode, also testify to this. Even in a high-speed stall, as shown by many years

of experience in testing, the aircraft lost speed at once to a value close to the minimum. The movement, probably a deep spiral, was controllable in this instance.

Existing literature on the specific features of flying in critical modes unfortunately abounds in errors and invalid conclusions. An impression of the spin as something unreliable, terrible, deadly and the like is thus created among the majority of flight personnel, and which does not correspond to reality. It is essential to remember first and foremost that pulling out of stall and spin modes is always connected only with exceeding the allowable angle of attack and is accompanied by intensive slowdown, as explained by the considerable value of inductive resistance, as well as the transformation of the energy of forward motion into energy of rotation.

The control surfaces become ineffective in pulling out of a spin due to the low velocity, which leads to the sluggish reaction of the aircraft to their positions. The controllability parameters, at the same time, are in inverse dependence to the magnitude of the angle of attack, and it is thus necessary to take this into account as well. It should be remembered that, despite the desire to accelerate the process of reducing this angle through the application of the stick entirely away from oneself, in that case the stabilizer drops into the region of disrupting the flow, and the effects from it are minimal. The maximum moment for diving is created by putting the stabilizer in a position close to the neutral. The complete application of the stick away from oneself under the unstable conditions of a normal spin could provoke the aircraft to turn upside down. The effectiveness of the rudder is reduced substantially in extreme modes (although it remains satisfactory) due to the blocking of the vertical empennage by the fuselage and other elements of the airframe.

It is no less important to clarify the operation of the elements of transverse control at large angles of attack. Their incorrect utilization could be the cause of both stalling and spin, as well as a failure to get out of them.

Sideslip slowing the rotation of the aircraft is increased with an increase in the angle of attack in the creation of roll. The magnitude of the available angular velocity is reduced in those cases. This leads, on some types of aircraft, first to "droop" in roll and, later, to the opposite reaction to the application of the stick. The stick cannot apply the ailerons against the rotation in this case. The rotation then only increases, and the aircraft inevitably gets into a spin. The transverse-control elements should be set only with the rotation in order to avert this. It may accelerate at first, but will then slow down.

The following conclusions can be drawn from the foregoing.

1. A drop in airspeed to a minimal value is testimony to the fact that the aircraft is in a spin. An increase in it, as well as the presence of angles of attack less than stall, testify to a pre-critical flight mode, and the rotation of the airframe is most likely occurring due to the applied control surfaces.

2. The ailerons must be kept neutral or set in the direction of the rotation in order to avert transition from stall to spin and rotation at stalling angles of attack.

3. The setting of the stick entirely away from oneself in a stall could lead to transition to a normal or upside-down spin.

4. Controlling the aircraft in the direction of the roll at large angle of attack must be done not using the ailerons, but chiefly the rudder.

5. The pilot waits for the answering reaction of the aircraft to his own actions with the rudder for one-two seconds; its delay could reach several seconds in critical modes and lead to disruptions of the feedback in the "pilot—aircraft" system.

6. The forces on the RUS in a non-boosted system in a spin could be alternating and erratic, but they are not so large that the pilot cannot overcome them. A person can manage this even on aircraft that are considerably larger in size than the L-39. It is important only that the pilot control the aircraft rather than hold onto the stick as a support.

7. The poor holding of the pilot in his seat could be a cause of serious interference both in control and in the event of emergency ejection due to the considerable accelerations in the rotation of the aircraft.

This article is not a textbook and does not encompass all of the essential information on the theory of the spin.

This "bouquet" of anomalies in control are not characteristic of any single type of aircraft, but could be manifested to this or that extent in flying various contemporary aircraft and future maneuverable ones.

Reflexive skills in aerobatic maneuvering, in short, must be adjusted in stalls and spins with conscious actions, the need for which, by the way, also arises in other critical modes—aero-inertial rotation, "wing drop," flying with a significant asymmetry in pods and engine thrust and the like.

How can the teaching of the spin be resurrected in the present day?

Lack of a systematic approach to the mass training of fliers will naturally lead to an increase in the number of flight accidents. It is thus necessary to start from the formation of instructors' groups and their training at the base of the Flight Personnel Training Center of the LII [Flight Test Institute] of MAP [Ministry of Aviation Industry] or some other flight-test organization. Relations among agencies have now been greatly simplified, and will not be a hindrance to it.

Sensible limits for the mastery of the spin according to the types of aircraft must also be determined, the training technique developed and a textbook with an allowance for the results of flight testing in prior years created. The point is that the books by M. Kotik and V. Filippov on this topic were written using materials a quarter of a century old.

We would like to say in conclusion that the flight parameters of stalls and spins do not promise to be simple for the latest and most modern aircraft, by virtue of the fact that they have a smaller reserve of stability in excess G-forces, or may even possess longitudinal instability. Their normal piloting is supported by automatic control and stability-improvement systems, including restrictions on the angle of attack, G-forces and automatic spin-pullout devices. But they, as was already mentioned above, still cannot eliminate completely the problem of critical modes.

And of course, the demands for the aerobatic mastery of the pilot or his abilities, in the event of getting into non-standard situations, to get the aircraft into normal flight using precise and conscious actions should hardly be reduced despite the advanced nature of the control systems being developed.

The opinion exists that there is no sense in teaching the spin, that it is necessary to follow the path of creating stall-prevention systems. But if the possibility of the aircraft getting into these situations actually exists and the pilots are aware of it, they must be given an additional chance to get out of them. How successfully the opportunity of averting flight accidents can be realized depends largely on the professional preparedness of the pilot.

Characteristics of Prospective Helicopter Fighters

91SV0014C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 12-13

[Article by Colonel (Reserve) G. Kuznetsov and Candidate of Technical Sciences V. Savin under the rubric "Tactics in Combat Training": "The Helicopter Fighter on the Attack"]

[Text] The appearance of combat helicopters made it necessary to outfit motorized subunits with AA artillery (ZSK) and AA missile (ZRK) systems. A certain parity has arisen between the "sword and the shield." But that equality is a temporary one.

The effectiveness of the site anti-aircraft defensive systems of the ground forces will rise considerably, in the opinion of military specialists, if they are given helicopter fighters (VI) and reconnaissance helicopters (VR) that are linked with the ZSK and ZRK in an informational sense. The enemy will in turn require analogous equipment, supporting the operation of combat vehicles, in order to surmount such an air defense.

The experience of exercises and testing have shown that the operations of the ground-attack aircraft and fighters against helicopters have not proven to be very effective due to the substantial differences in technical characteristics and weather minimums. The concept of "helicopter against helicopter" has been affirmed. And that is not just from the perspective of the future alone. Reconnaissance helicopters already exist in the United States. All that remains is a rotary-winged fighter. Helicopter firms in many countries are trying to adapt existing craft to the waging of aerial combat, with greater or lesser degrees of success.

The Americans are intensively developing a version of the AH-64 Apache helicopter for this purpose. The possibility of employing other combat craft being created under the LHX program is being considered at the same time. It is proposed to include among their armaments rapid-fire cannon in turrets and self-homing air-to-air missiles such as the Stinger, Sidewinder, Sidearm, Mistral and Starstreak.

The monetary expenditures on the solution of the problems enumerated above testify to the scope and depth of the projects. More than 150 million dollars, for example, have already been spent on researching the possibilities for employing the Stinger missile on helicopters. Special ground modeling complexes have been created at four helicopter-building firms in the United States under the LHX program, at a cost of roughly 80-100 million rubles apiece, that make it possible to conduct research on aerial battle between helicopters. Finally, four stages of the flight run-through of solitary and group aerial battles among rotary-wing craft have already been completed within the framework of the program to create a special helicopter fighter (ACAF), starting in 1986, on which 50 million dollars had been expended by the start of last year.

Aircraft builders in France and the FRG are also occupied with the solution of analogous problems. The most successful among them, in the opinion of specialists, could prove to be the light fighters based on the French Epsilon aircraft, designed for low speeds and the maximally low flight altitudes.

All of this is forcing our country to take into account the projected trend in the creation of this new type of military hardware in planning future projects as well.

The helicopter fighter should first and foremost meet the requirements that are defined by the conditions of the combat operations it wages. It should not, that is, differ in performance characteristics from combat and reconnaissance helicopters that, as a rule, perform their missions close to the front lines over the battle formations of ground forces under the condition of rugged terrain and in the effective lethal areas of AA defense. The performance of maneuvers without restriction is possible only on a horizontal plane, as a rule, in such a space. The use

of vertical and three-dimensional maneuvers is restricted from below by the possibility of collision with the ground, and from above by the boundaries of the lethal areas of AA systems.

It is felt that the basic principles for waging aerial battles among aircraft are wholly applicable to helicopters as well. They will also strive to be the first to detect and identify the enemy, anticipate him in opening fire and react in timely fashion to hostile actions with the use of effective tactical methods. Aerial battles may be hypothetically divided, according to the conditions of application of on-board weaponry, into long-range missile or close-in maneuvering battle, by the number of participants into group or solitary, and by type into offensive or defensive.

The airspace in which helicopters will have to conduct combat encounters is typified by the presence of a multitude of dust and smoke formations. This feature makes the detection of airborne targets at great distances more difficult, but is favorable to the execution of surprise attacks from medium and short ranges. This is the fundamental difference in the conditions for waging aerial battle by helicopter as compared to a fixed-wing aircraft.

The principal mission of the helicopter fighters assigned to the air-defense forces is reduced to protecting subunits with armored equipment, ZSK, ZRK and strike and assault helicopters against enemy attacks, especially from the air. They are entrusted with the functions of destroying helicopters of all types, ground-attack aircraft and other airborne targets, as well as ground AA systems.

These missions can be performed, in the view of foreign experts, only by a specially designed helicopter. Its dimensions and weight should be as small as possible. It will need, at the same time, extremely powerful engines that possess high acceleration capacity. It is important to make the craft very maneuverable and faster than analogous enemy aircraft. It is felt that the VI, as the result of a summarization of all these requirements, should:

—have a static ceiling as for combat helicopters, with a top speed 30-50 km/hr greater than them;

—possess the ability to fly at the lowest possible altitudes with terrain following, as well as maneuverability that supports the execution of steep climbs and dives with pitch angles of $\pm 90°$, turns with a roll of up to $\pm 90°$, three-dimensional combat maneuvers with normal G-forces of -1 to 3.5 Gs, "pedal" turns while hovering and when entering into motion at great angular velocity;

—possess high combat survivability through low detectability, armor protection and maneuverability in combination with the use of on-board EW/ECM equipment;

—have as part of the on-board equipment a targeting system that allows an all-round view and the detection and identification of airborne targets at long range, under conditions of poor visibility and jamming, as well as reliable IFF systems and laser- or radar-illumination warning systems;

—have a helmet-mounted target-designation and weapons-control system that provides for the rapid aiming and opening of fire along with a system to warn of convergence with obstacles, making it possible to unburden the pilot as much as possible and leaving him only the actual flying at the decision-making level; and

—have cannon and missile armaments located on rotating weapons platforms, which should ensure, combined with the good maneuverability of the helicopter, the effective use of the weaponry in the surprise detection of the enemy at any aspect angle. The launch of the hypersonic air-to-air missiles should be accomplished according to the principle of "fire and forget."

These requirements, many of which are contradictory, naturally cannot be realized in a single craft. It would simply be unable to get off the ground. The helicopter fighter that most fully meets these requirements is created according to the criterion of cost effectiveness, with a regard for the effects of various characteristics on the integral quality of the helicopter as a weapons system.

Specific missions in training for the helicopter fighter will also arise at the same time. The advanced aerobatic maneuvers that are performed using helicopters by sport and test pilots will hardly be able to find practical application in aerial combat in unadulterated form. Rudimentary maneuvers and individual elements of advanced aerobatic maneuvers, along with well-known flying maneuvers such as the steep climb, dive, sharp turn, chandelle, turn in steep climb and "pedal" turn while hovering and in forward motion will be employed under combat conditions, in the opinion of practical specialists. It is considered essential that the pilot have at his disposal a "bag of tricks" that includes the ability to execute difficult advanced maneuvers for the non-standard piloting of the helicopter in aerial battle.

How successfully he makes use of these maneuvers depends on his level of mastery. One criterion of the maturity of a crew is considered to be not only its ability to react correctly to an unfolding situation, but also an ability to predict it. Specialists presume that any country that receives the triad of VR—combat helicopter—VI and is able to integrate it into the overall conceptual framework of military confrontation will have a great supremacy over the enemy in the event of an incursion by his armored and air-mobile forces, which is especially important under the conditions of waging defensive combat operations.

Reliability of Flight Personnel Linked to Flight Safety

91SV0014D Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 14-15

[Article by USSR APN [Academy of Pedagogical Sciences] Academician and Major-General of the Medical Service V. Ponomarenko under the rubric "Combat Training and Flight Safety: A Scholar's Opinion": "The Professional Reliability of Flight Crews"; conclusion to follow]

[Text] *The link between the level of flight safety and the professional reliability of flight personnel has currently been very much laid bare. The human factor figures in the majority of cases in materials analyzing the reasons for air mishaps—the number of accidents and catastrophes with aircraft in good working order is increasing, while the flying time per accident is dropping. An intelligent question arises: is this phenomenon a random or inexorable one? What explanations are provided by science?*

I have always defended the point of view that the increase in the accident rate is due to the effects of the human factor—an inexorable phenomenon. It was suggested by science long ago, but this was not taken into account in aviation units for a number of reasons. There are many causes of this, but I will dwell only on those that have not yet become the property of the flier's consciousness. It is first and foremost the fliers themselves, in propagating the principle of seeking out those to blame since as far back as the 1920s, who have formulated the stock thinking that is so convenient for the supporting services: the pilot is the final link in the chain of causes of accidents. Only in the last two or three years has it come to be officially acknowledged that pilot errors are far from always the source of the tragedy, since they often do not entail his personal blame. The stance of the Commander-in-Chief of the Air Forces, Colonel General Aviation Ye. Shaposhnikov, is heartening: "...let us firmly agree, when everyone wants to blame the deceased, that that is not the way to seek the causes of flight accidents."

I would note, in returning to the idea of the causes of the unfounded view of the prevalence of the guilt of the human factor in accidents, that this has become possible first and foremost due to our poor knowledge of the person, his psychological states and psycho-physiological laws of behavior in flight and the capabilities of the mind and the organism, not to mention the motives and needs of the flier as a personality in a dangerous profession.

It is well known that the engineering sciences are occupied with airframes, concentrating their efforts on seeking solutions to the problems of **the reliability of the aircraft** in the air, while the assurance of **the reliability of the person in flight** is entrusted to the process of flight training all by itself. And the result is no accident: the preconditions for flight accidents due to equipment failures and errors of the person, according to average statistical data, are in the ratio of 3:7. The dramatic nature of this ratio is not so much in the quantitative difference as it is in its very essence, since the pilot is named as the cause of the unreliability of the human factor as before. Where are the roots of the paradox?

First of all, despite the substantial increase in the complexity and diversity of the combat-training missions being performed using the new aircraft, aviation pedagogy is nonetheless still dominated by the principles of walking it through, abstract and instruction. One can run through no more than a third of the exercises envisaged by the combat-training courses of study on modern simulators with any use at all. The mastery of the aircraft coming into service begins, as a rule, without any dual trainers or simulators. To this should be added the fact that each of them is accompanied by a State Testing Act with a list of 200-300 flaws of an ergonomic or engineering nature, many of which are eliminated only through the removal of the combat aircraft from service. Imperfections are "hidden" behind specific features and restrictions, and special exercises for adapting to them are rarely provided for, say, at the pilot's workstation. More than half of the erroneous actions with control panels and controls on third-generation aircraft prove to be unexpected for the crew itself, since their professional skills were acquired in course of operating older equipment.

Second, the attention toward the development of airframes and support for flight activity differs markedly. Special OKBs [experimental design bureaus], dozens of NIIs [scientific-research institutes], experimental production, flight-test complexes and proving grounds have been organized for the developers of the equipment. Institutes of the USSR Academy of Sciences are involved with the solution of many problems. An average of 1.5-3 billion rubles are allocated for the development and testing of a new-generation aviation complex, while a hundredth of that, at best, is put out for raising the reliability of the human factor—improving selection, training, indoctrination, the physical plant for training and the like. The Institute of Aviation and Space Medicine of the Air Forces was allocated only 800,000 rubles for the five-year plan, for example, to resolve **all** of the issues connected with adapting the human factor to the MiG-29 then being created.

Even the minimally necessary funds for protecting the eyes against the emissions of quantum generators, or pilots against G-forces, for rehabilitated health centers, trainer set-ups using centrifuges, computers for training and much more were thus not received despite the scientific projects already in existence, all of which would have increased the reliability of the flight personnel by two or three times, including as professionals. And it is no accident that 21 percent of the pilots had diagnoses before the start of MiG-29 assimilation, and 40 percent did two years after the start of operation.

This state of affairs is no secret to anyone now. The basic cause of it is the **methodology** of the creation of man-machine systems, when reliability is designed unilaterally for the aircraft while the person is relegated to "outside the brackets," since his reliability is presented in the form of fitness for work, which is not directly under the purview of the instructor. And that is notwithstanding the truisms that the effectiveness of the pilot's activity depends directly on the conformity of the parameters of the aircraft control system to the laws of the feel of the person's actions on the control elements, on the angles of view from the cockpit, the illumination of the instruments, the geometry of the configuration of the instruments and panels in accordance with the configuration of the body and, finally, the level of protection against noise, vibration and electromagnetic emissions, among other things. The reliability of the human factor, in other words, should **be made inherent by the designer** at the stage of design engineering. It has been proved experimentally that about 40 percent of the errors are inherent in the contemporary design engineering, and the responsibility for reducing work fitness in the form of unsound actions due to ergonomic flaws can therefore fairly be placed on the developer and the designer.

But we must also give due to what has been accomplished. The state of affairs in ergonomic support for the reliability of the crew has been improved in the creation of fourth-generation airframes. It is enough to say that the number of errors for this reason has decreased by three or four times on the MiG-29 compared to the MiG-23. Attention toward the personality of the pilot can be discerned to a greater and greater extent in the new aircraft. Its operation requires much higher than average intelligence, physical and professional health, visual-effect and operational-tactical thinking, flexibility and resilience of the nervous system with the high moral spirit and standards of a professional. The main thing is that the equipment provide greater **independence** in the choice of maneuvers and require an organic combination of the feeling of responsibility and knowledge of one's capabilities. Flight safety in fourth-generation aviation systems depends, as never before, on the level of self-awareness of the pilot and his standard of conduct.

And there is a psychological paradox once again. It would seem that today, when the requirements on the part of aviation equipment are growing and the complexity of the tasks for the crews is increasing, concern for the pre-training of the flight personnel in many areas must duly be improved. By way of example, the "weight" of the pilot's body can increase by ten (!) times over one second in piloting a fighter, and the loads on the spinal column and the spinal medulla connected to it can increase by seven or eight times over a tenth of a second when landing on the flight deck of an aircraft carrier. Questions of social protections for the crew and support for their families in the event of death or loss of profession by the breadwinner, it would seem, should become **a universal moral obligation**. But nothing of the sort, unfortunately, is happening at any level of the vital activity of the aviation collective: professional orientation, selection, training, preparation, rest, family, everyday life etc.

The insufficient display of attention toward the human factor could also be shown using the example of psychological selection. All matriculants at the service schools undergo testing. A prediction of those qualities of the psyche and personality that will facilitate the successful mastery of the flying profession is made proceeding from the model of a professional. A nine-point scale of evaluations has been developed today for the results of the tests, on the basis of which those being tested are divided into four groups. The following figures testify to the high degree of corroborability of the prediction: an average of two percent of the cadets in the first groups are dismissed from all the service schools for poor flight progress over the training period, while it is 10 percent for the second group, 23 for the third and 70 for the fourth. The errors committed that threaten flight safety correspond to 14, 25, 50 and 92 percent of those studying by groups respectively.

The matriculants to the service schools, according to existing data, are comprised of about 40 percent from the third group, while the first group is no more than 10-15 percent. The social mechanism that regulates this process would naturally increase competition to 10-12 people per slot with the arrival of new equipment. And it has declined, periodically falling to one-three people. This signifies that the problem of flight safety has only been announced as a task of statewide importance, while it has in fact receded to the periphery of departmental needs.

Only 30 percent of the graduates of the service schools were wholly suited to service in aviation in the 1980s, while 50-60 percent had average flying abilities and 10-20 had poor ones. Analysis of the process of adaptation of the individuals in the third group to flight work has shown that they, as compared to the first and second groups, not only make errors and are ill more often, but also have a markedly shorter flying longevity as well.

This research into the flight personnel (more than 800 people) has turned up about 15 percent of the personnel with unfavorable personality traits: they are impulsive, reserved, mistrustful, emotionally unstable, anxious, excessively egotistical or have rigid dispositions. This is characteristic of 3-5 percent of the command personnel. Conflicts are noted among these people as expressed in egotistical dispositions, coarseness, an inability to understand subordinates, excessive impulsiveness and lack of inhibition, indecisiveness, vulnerability and an inclination toward conformism. *[Conclusion to follow]*

Special Boarding Flight Schools in Yeysk and Barnaul

91SV0014E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) p 18

[Articles by Lieutenant-Colonel V. Smirnov and by A. Mozzhukhin, director of the special boarding school at Yeysk, under the rubric "For Those Who Choose the Sky": "Special Boarding Flight Schools"]

[Text] *"I dream of becoming a fighter pilot. I have heard that boarding schools have been opened for basic flight training. But what they are and the conditions for acceptance are not known. Please talk about that if possible."*

There are many letters with this request in our mail. The editors herein satisfy the desire of the young readers. Lieutenant-Colonel V. Smirnov answers their questions.

Special boarding schools for basic flight training have been opened as of 1 Sep 90 in Yeysk (353660, City of Yeysk in Krasnodar Kray, Ulitsa Plekhanova, 15, Boarding School) and Barnaul (656099, City of Barnaul, Altay Kray, Ulitsa Kutuzova, 22) based on USSR Council of Ministers Decree No. 679 of 25 May 88. They are not special schools of the Air Forces, as was erroneously announced in a number of publications, but rather function within the national educational system.

These special boarding schools are intended:

—to provide students with secondary education and basic flight training using light sport aircraft, facilitating subsequent successful study at higher military aviation service schools for pilots;

—to cultivate among the students, based on the requirements for the profession of pilot, lofty moral and military qualities, discipline, an awareness of public and military duty, love of military service and readiness to protect the Fatherland; and

—to prepare young people who are physically fit and hardy, able to withstand difficulties in sturdy fashion.

Young people 15-16 years of age who have completed nine grades and are physically suited for entry into military aviation service schools for the training of fighter and fighter-bomber pilots are being accepted into the special boarding schools. The selection is made by educational bodies in conjunction with the military commissariats, Komsomol committees and sport-aviation organizations of DOSAAF according to place of residence.

The following documents are required before matriculation: application with note of consent from one parent (or person substituting for them) to the rayon or city educational department, submitted during the period from June 15 through 30; a notarized and certified copy of the birth certificate; a certificate of incomplete secondary education (or completion of elementary school); information on the composition of the family; information on the place of work of the parents; a medical resolution of the state of health issued by the physicians' commission of the military commissariat according to place of residence; and, four photographs measuring 4 x 6 centimeters (without hat). The visit to the commission and exams are by summons of the school. The trip is paid for by the parents.

The youths complete medical certification by the flight physicians' commission (VLK) of the local aviation organization of DOSAAF or a flight school, as well as a check-up of physical preparedness, during final selection. Those who have passed through the VLK are given one examination on a subject in the natural-mathematical cycle (by choice) and complete an interview on literature and history in the amount of the program for incomplete secondary school. Individuals who have completed nine grades with distinction or were awarded the honorary certificate "For Special Success in the Study of Individual Subjects" are excused from the competitive examination and interview.

In acceptance to the special boarding school, preference is given, all other things being equal, to youths who have completed preliminary air training in schools for young fliers, aviation organizations of DOSAAF or other institutions. Candidates who are orphans or are not under a parent's care and are physically fit for flight training are enrolled at the school first of all.

The students of the special boarding schools are maintained on full state support. The term of training is two years. The flight training is conducted after the completion of the 10th grade, in the summer, and during the 11th, in the winter.

Students who have completed the special boarding schools and meet the requirements for matriculation to higher military aviation schools for pilots are sent for training and enrolled at them without entrance examinations.

One may become familiar in detail with the Statute of the Special Boarding School with Basic Flight Training at the city military commissariats, where they hold the order of the USSR Minister of Defense and the chairman of the USSR State Committee for National Education No. 480/959 of 24 Dec 89. Information can also be received by telephone to the commission offices, 4-81-80 in Yeysk and 25-42-72 in Barnaul.

We Invite You to the Yeysk School

More than 500 young people visited to try and enter our school in the past year. Candidly speaking, they were not all lucky. And that is entirely understandable, since they had to pass through the medical commission and examinations and meet sports standards on the road to the achievement of their aims.

This is a step already completed for 180 lucky ones, and difficult but interesting work lies ahead. The young

people have at their disposal a modern training wing with well-equipped rooms, a sports and assembly hall, a stadium and accommodations for study groups.

The training process at the school has been entrusted to pedagogues with a great deal of experience in working at military aviation schools: Colonel A. Shkurpit, Lieutenant-Colonels V. Lazovskiy and R. Krykbayev, teachers V. Kulakov, S. Khilchevskaya, Ye. Tarasova and many others. Lieutenant-Colonel V. Likhoded, Captain V. Goslinskiy and Senior Warrant Officer V. Logvin also participate actively in organizing the work and rest of the students. The practical teaching of flight matters will be conducted under the leadership of experienced flight instructors using Yak-52 aircraft. Businesslike relations have been established with the Yeysk Higher Military Aviation School for Pilots, which takes part in training our students.

The school has been created, but there are still many unsolved problems: there are not enough funds to complete repairs on the second phase of the dormitory wing, for amenities for the campus, for the acquisition of transport and musical instruments etc. The collective hopes that help will be given not only by the organizations in public education, but also the leadership of the Air Forces, cadres for which are trained at the school. The new educational institution needs material and financial support from its sponsors. We are appealing for assistance to all who are not indifferent to the fate of future military pilots—the protectors of our Motherland!

A. Mozzhukhin, director of the special boarding school

System Proposed for Rating Places of Service

91SV0014F Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 22-23

[Article by orvb [detached maintenance and repair battalion] commander Lieutenant-Colonel S. Okunev under the rubric "Military Reform and Social Justice": "Whom Do the Urals Divide?"]

[Text] *I recall how the USSR Minister of Defense, at the first session of the Congress of People's Deputies, asked in perplexity that a question on social protections for servicemen be repeated: "What, is somebody not fed? Just what are we talking about?..."*

There was, meanwhile, it seems to me, something to talk about. Social protections for servicemen, like social justice in the army, have a broad range of unsolved problems. I am personally trying to illuminate just one of them: why do some officers serve their whole lives in Moscow or around it, while others are in Chita and in the boundless polar regions? I feel that the time has long since come to solve fairly the problem of the distribution of jobs in deed, rather than just talk, without, by the way, ignoring the normal human desire to live better.

I thought for a long time about whom among the superior officers to approach with my "seditious" ideas, but I did not find my target that way: would those who, as they say, on whom it doesn't rain, people with air conditioners installed in comfortable offices to handle the heat or cold, understand me? I thus decided that only a broad discussion of this problem would help to answer the question of whether social justice exists in determining the service locations of individuals in the officer corps. I believe that the journal AVIATSIYA I KOSMONAVTIKA, which has taken the path of protecting the interests of the fliers in the line units, would help with this.

I once conducted a poll of officers who had completed service in remote garrisons. To my question "Do the existing incentives for individuals who perform their service in remote locations or areas with difficult climatic conditions compensate for the spiritual, material, physical and other costs of servicemen?" an absolute majority answered unequivocally that no, they do not. And there is nothing surprising in that.

Let's think about it: is the situation of two officers, one of whom is serving in Moscow and the other in, say, Kizyl-Arvat, comparable? The latter, comprehending the temporary nature of his location, dreams of one thing—God grant that I end up in a decent garrison by the end of my service and am able to get an apartment, since after my discharge I won't get one for a long time more. Everyone knows how the country takes care of reserve officers. It is a national disgrace! The former has no intention at all of changing his place of service; he not only gets a decent apartment and good job over many years, but even has opportunities to learn, educate himself, take care of his health, get his children set up and the like.

We have been schooled not to speak of this from the rostrums, the more so appear in the press on this subject. But what can you do if the majority of the officers encounter these problems, as they say, head on? Many of them and their families, even after discharge into the reserves, continue to "bear doggedly all of the burdens and deprivations..."

There is another aspect here as well. The civilian population of major cities often makes its judgments about officers according to those who are working at various headquarters, institutes and academies. That is where the public opinion is formed that the military have no particular problems. But excuse me, what relation do the officers, from lieutenant to colonel, serving in Moscow, Kiev or Minsk have toward actual burdens and deprivations (in which service in the line units abounds)?... They have everything, as a rule—an apartment, a car, a dacha, a job and the help of highly placed relatives. And most important, they are still invulnerable, since it is very difficult to prove a protégé. Everything, after all, is resolved with the help of telephone calls and in tête-à-tête conversations.

We have a unique situation today. Can it really be considered normal to have a 15-percent pay supplement compared to the service conditions in Moscow, Kiev or Leningrad? And equal compensation for Alma-Ata and Uch-Aral? I could cite many such paradoxical examples that defy logic. How can this profanation be fought?

It is extremely essential, in my opinion, to develop a technique for rating each specific garrison. It could be based on an expert poll of officers who are completing service in various districts, ultimately having, say, some average statistical valuation allowing for the benefits that exist in those places. Such benefits as monetary supplements (not 15 percent of the salary, but up to 100 rubles, 240 rubles, 1.5 times or twice the salary), duration of time off (from 30 to 45 days), term of service (month for month, one month for 1.5, one for two, one for three) or stipulated times for replacement (not in ten years, but in five or three), as well as other criteria: administrative divisions, provision of housing, the number of social and cultural facilities, supplies, the presence of cultural-enlightenment establishments etc.

I feel that the size of the population at the point where the unit is stationed (none, up to 10,000, 20,000, 100,000...), the remoteness from cities with a population over 500,000 (an hour's travel away, more than two, six or twelve hours) and the remoteness from the center of the European part of the USSR (a day, up to two, four, six, eight) must be taken into account when developing the technique for rating the garrisons.

I am taking into account fully the fact that the development of this technique (moreover on a scientific basis) is a far from simple task. It is, however, exceedingly necessary, insofar as the discussion concerns social justice. There has been enough occupation with ideological idle talk and word games, and it is time to move from words to concrete deeds.

The essence of the proposed technique is that each garrison institute its own rating (as a point total). It will be as much higher as the service conditions are more difficult and the stipulated benefits are less. The possibility will then arise of a more objective comparison of the garrisons and a differentiated approach to analyzing an officer's service record. I will try to demonstrate this with an abstract example.

Say that officer I.I. First was sent to a garrison in Chita for six months after completing the service school, and was then transferred to Moscow, where he served six and a half years, after which he entered the academy. Officer A.A. Second, after service school, was sent to a garrison at Nebit-Dag for three years, then to Kizyl-Arvat for four years, and then entered the academy. Both officers have thus served seven years each. Let it be stipulated that a year of service in the garrison at Chita is valued at 25 points, Moscow 20, Nebit-Dag 80 and Kizyl-Arvat 90. Then officer I.I. First collects 142.5 points (25 x 0.5 + 20 x 6.5), while A.A. Second has 600 points (3 x 80 + 4 x 90). It is thus visibly clear where the officers need to be sent after completion of the academy. Officers who serve in the armed forces at different times can use an average annual rating—that is, the quantity of points collected is divided by the years of service—for comparison purposes.

This approach to the matter will make it possible, in my opinion, to assign officers to higher positions and transfer them to new service locations in a spirit of glasnost, from the standpoint of social justice. Each of us will be able to answer objectively the stirring question of "Why was he assigned (transferred) instead of me?" I feel that hope could thereby be returned to officers for an even burden over the service process depending on personal contributions and abilities, rather than in accordance with the official position of relatives and good friends. The legal protections for servicemen against the whims of the commander are also increased therein—"you won't be getting any transfer until you build a shelter for the vehicles." This technique will also simplify considerably the work of personnel bodies—it is sufficient to set up an intelligent computer program—and the whole picture will be clearly visible.

One prospect for the development of the proposed technique—which will doubtless stimulate the desire of officers to serve under even the most severe conditions—could be the summing of the points (over the entire period of service) when being discharged into the reserves, with the calculation of the pension depending on the quantity of points accumulated. This would make it possible to compensate at least partially for the costs to an officer who remains without an apartment or other things at the end of his service. I feel that this would help change the attitude of officers, at least to some extent, toward service in remote garrisons. It is time to understand that trafficking in such concepts as conscience and tolerance toward drawbacks, among others, has exhausted itself. A material vested interest for people is needed. The inclusion of the technique in analyzing and reporting on salaries is also possible in the future. The commander of a technical company and the chief of the clothing service, for example, have the same salary, while the difficulties in their service are not commensurate.

As for the obstacles that could appear in the realization of this proposal: The first of them is the selection of candidates for the performance of the expert evaluations. It will not be easy to battle the subjectivism of the person or group of people who are bringing all of the information together. The chief problem, however, is that those who have no vested interest in this proposal—the representatives of the army elite, the sons of highly placed officials—will try to derail it straight away. And they have no little power in their hands.

As for the development of this technique: It will take root and be able to function only when an enormous amount of material on poll results is collected and analyzed attentively and in detail by dispassionate people, and then tested on a varied groups of officers. Servicemen in one field in a branch of the armed forces,

on the scale of a single military district, or a type of service or an entire branch, for example. Corrections must be made in the technique after each test until the greatest possible level of perfection is attained.

And last: Many good ideas are not realized due to the turnover and shortage of intelligent performers that has overwhelmed us. If this approach is to find widespread approval, let us ourselves find the people who will perform this work in the least possible time and submit their material for consideration to the appropriate authorities.

Battles of MiG-15 and F-86 Aircraft in Korea Summarized

91SV0014G Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 32-33

[Article by Hero of the Soviet Union Lieutenant-General Aviation (Retired) G. Lobov under the rubric "'Blank Spots' in History": "In the Skies of North Korea"; continued from Nos. 10-12 of 1990]

[Text] "MiGs" Against "Sabers"

The fight against aerial reconnaissance was not very noticeable against the background of the large-scale and quite dogged battles of the Soviet pilots with the crews of strategic aviation and fighter-bombers of the U.S. Air Force. Taking into account its significance and effect on the course and results of combat operations, however, I would like to acquaint the readers with this unknown page of the war in Korea as well.

The air supremacy before the entry of Soviet jet fighters into battle allowed the enemy to conduct aerial reconnaissance virtually around the clock and without interference. It was accomplished by special B-45 Tornado reconnaissance aircraft, as well as RB-26 and RB-29 bombers fitted with special gear. The crews of fighter-bombers and fighters also conducted tactical reconnaissance. All these means of looking, listening and photographing were usually operating over the territory of North Korea without any cover.

The peaceful life of these reconnaissance aircraft came to an end with the appearance of the Soviet MiGs. Soon the Tornadoes—there were just three of them, according to our data—were destroyed. Our pilots also shot down RB-26s and RB-29s, even when they were defended.

The Americans quickly realized that the use of bombers as reconnaissance aircraft either separately or under fighter cover was now impossible. The decision was thus made for them to fly as part of groups of same-type aircraft. This naturally reduced the effectiveness of the reconnaissance. The crews of the RBs also later became "night people" with the conversion of bomber aircraft to exclusively nighttime operations.

The entire burden of conducting aerial reconnaissance during the daytime in the zones monitored by the MiGs fell upon fighters equipped with special gear. They performed their missions, as a rule, under strong cover from F-86s. Cases were noted when the work of a single reconnaissance aircraft in the regions adjoining the Yalu River was supported by up to 40 fighters. We naturally obtained some information on the presence of reconnaissance aircraft in this or that aviation group. Intelligence from radio eavesdropping, for instance, was used for this purpose. The reconnaissance aircraft was usually called a "jock" in the jargon of the American pilots.

It was, at the same time, not very easy to discern the "jock" among like aircraft when encountering such a group. Even if it differed outwardly from its escorts (the Americans sometimes used naval Panther fighters for performing this mission), its detection was not the end of the job. And it proved to be very difficult to shoot them down in this or that case. The whole armada, after all, rushed to its defense. The reconnaissance fighter itself could also successfully wage a defensive battle or escape at high speed to a safe zone.

It must be stated that we were unable to impede entirely the performance of reconnaissance by fighters. But we were able to accomplish a great deal nonetheless. And, most important, we reduced appreciably the effectiveness of enemy aerial reconnaissance, restricting his opportunities by the time of day and in the use of reconnaissance equipment (much would not fit on a fighter). A collateral but no less important result of this struggle for us was the forced removal of a large number of F-86s to cover the reconnaissance aircraft by the opposing side.

Today, when readers are up to speed on the basic events of the war in the skies of Korea, there is a need to talk some of the approaches to illuminating it on the part of American specialists, historians and literary people.

Many authors, boosting the F-86 Saberjet aircraft—actually not a bad one for the times—paint a brilliant picture of the successes of U.S. fighter aviation in the battle against the MiG-15 against this contrived background. The contrived losses of MiGs and the soundly understated number of Sabers shot down serve as the reasoning for this. All of this arithmetic is given separately from the overall results of the aerial battles. Descriptions of individual duels, outside of their connection to the operational and tactical situation or the missions being fulfilled at a given moment by the aircraft of the opposing sides, occupy an inordinately large place. This widespread propaganda device does not withstand any criticism if we look at the missions of the MiG-15 and the F-86 through the eyes of an objective researcher.

The chief targets of MiG operations were the U.S. Air Force bombers and fighter-bombers. We were unable to cover the whole territory of North Korea against the raids by American strike aircraft. We did not have enough manpower or equipment for that, as I have

already mentioned, or the freedom of maneuver or initiative due to the prohibitions and restrictions that were in existence at the time. Soviet pilots nonetheless substantially reduced the combat capabilities of the aggressor's aviation and inflicted enormous losses on him. We only fought the F-86s when they impeded the MiGs from penetrated to the bombers or fighter-bombers, as well as in chance meetings. I have described in prior issues of the journal how those usually turned out.

The showcasing of individual duels outside of any connection to the overall aerial situation is also advantageous in that it allows the concealment of the truth behind colorful descriptions. Namely that while the American pairs of Sabers were wheeling with a cluster of MiGs, the principal forces of Soviet aviation were destroying the bombers or fighter-bombers, essentially abandoned by the F-86 pilots to the whims of fate.

The most authoritative American military specialists also acknowledge the secondary role of "pure" battles between the Sabers and the MiG-15s as compared to the MiGs versus strike aviation. Colonel C. Teschler, to whose opinions I have already made reference, writes, for example, that the battles between the F-86s and MiG-15s were paramount only to philistines, while the combat operations of the fighter-bombers were more important. Representatives of the bomber command also adhered to the same point of view on the priority of strike aircraft.

If you generalize from the overall situation and analyze the results of the duels between the MiG-15s and the F-86s, as well as the clashes of the mixed groups where MiGs encountered Sabers, you come to the conclusion that these battles were mostly ineffective both for us and for the Americans. Even allowing for the fact that we had much smaller losses in battles purely among fighters. The issue here is only Soviet aviation, since I do not have precise data on the losses of the OVA. It seems that it was much more difficult for the Korean and Chinese pilots in their encounters with F-86s, since they did not have adequate tactical air training.

The poor effectiveness of battles against fighters, aside from the fact that they were not the chief targets for us, is explained by other objective causes as well. The speed features of the MiG-15 and F-86 were roughly equal. The use of the MiGs in battle proved to be a complex matter, even though they had a greater rate of climb and thrust-to-weight ratio, since the Sabers picked up speed faster in a dive. They were moreover somewhat more maneuverable than the MiG-15, which often allowed the American pilots to escape attacks.

The high speeds of convergence (about 2,000 km/hr) made the use of weaponry more difficult on head-on headings, and the enemies frequently broke off with little result. The opportunities for attack in pursuit were also limited, since the convergence was too slow and the effective firing ranges of the armaments, even cannon, were comparatively small.

The correct choice of tactics played an enormous role in group aerial battles. The author of the article "MiG-15 Fighter Maneuvers," recognizing the high tactical skills of the Soviet pilots, analyzes more than 30 tactical devices that were noted for the first time by the Americans in Korea. The most widespread combat maneuver in meetings of MiG-15 and F-86 aircraft was the so-called "less-than-vertical loop." The MiGs moreover strove to pull out of them upward, while the F-86 pilots went downward.

The Americans, in comparing the MiG-15 and the F-86, acknowledge the good combat qualities of the Soviet fighter. One participant in the Korean War, Colonel G. Ting, notes in the article "Battle in the Air" that "We established that this was a durable aircraft with few design limitations. This is a terrifying aircraft when it is controlled by a skilled pilot with initiative who is able to make use of its good characteristics."

And here is a conclusion drawn on the basis of concrete facts. Soviet fighter pilots shot down many well-known pilots of the U.S. Air Force in battles with the F-86. They included the commander of an air wing, Colonel (Makhurin), a man considered an ace, Major Davis, and other experienced fliers.

The success of our pilots in battle with enemy fighters, however, does not show up either in the number of F-86s shot down or in the correlation of mutual losses, but rather chiefly in the fact that the Sabers could not impede us in inflicting a major defeat on the bomber and fighter-bomber aircraft of the aggressor.

Many Soviet pilots showed themselves worthy successors to the heroes of the Great Patriotic War and true masters of aerial battle in fulfilling their missions. N. Sutyagin and Ye. Pepelyayev shot down over 20 enemy aircraft apiece. L. Shchukin, D. Oskin, G. Pulov, G. Okhay, S. Kramarenko, G. Ges, A. Smorchkov, A. Boytsov, D. Samoylov and S. Bakhayev, among others, have more than ten victories to their credit. Some 22 pilots were awarded the title of Hero of the Soviet Union for courage and high skill. They included 12 from the 303rd and six from the 324th fighter air divisions. *(To be continued)*

Officer Complains of Difficulty with Ordnance-Loading Equipment

91SV0014H Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) p 35

[Article by Senior Lieutenant G. Mamontov, chief of a missile preparation group, under the rubric "IAS: The Problem Requires a Solution": "How Do We Prepare for Battle?"]

[Text] To say that they are not all that concerned about the equipping of the armaments service is to be unfair to the developers of the aircraft technology. They are doing a thing or two, but the quality and efficiency of the mechanization equipment is clearly too low.

The picture during the flight shift is one and the same at airfields—virtually all the personnel of the IAS [aviation engineering service], regardless of their occupation and an abundance of other, no less important tasks—are engaged in transporting and loading ordnance in pre-flight preparations and preparations for repeat sorties. What can you do? We can so far only dream of all-purpose dollies that are suitable for any type of aircraft.

What sort of things exist now? The maneuverable dollies for transporting ordnance are very high and do not fit under the pylons of the helicopters, and the hanging of these items, especially large-caliber ones, is very labor-intensive. The dollies for the storage and transport of guided missiles are more convenient. They make it possible, in principle, to reduce considerably the time period for delivering the missiles to the aircraft, which is very important in bringing the unit to various degrees of combat readiness. But not everything has been well thought out there either—they can be moved by a small number of specialists only on concrete hardstands or level, compacted ground in good weather. The helicopters, as a rule, are based at sites that are not prepared well enough during exercises. The 400-kilogram dollies have to be pushed by everybody when dispersing them or, on the contrary, bringing up the ordnance. The transport platform itself also has a substantial drawback: the maximum loading with ordnance does not corresponding to the variations for outfitting the helicopters.

But even this transport equipment does not suffice. So we make use most often of what is always "at hand"—our own hands. The generations of aircraft serviced by the specialists change, but things, as they say, have not moved, they remain in the past. A solution for moving two boxes with ordnance using three rather than four people, two at the edges and one in the middle, is to be considered an achievement of "soaring designer thought" in raising the efficiency of our labor. There is your "innovative proposal" for reducing the number of service personnel and labor expenditures.

I am proposing, in order to move matters from a dead standstill, that we study the experience of units operating helicopters and determine the essential range of small-scale mechanization equipment, which should be based on convenient self-propelled equipment on small motor vehicles. Its creation, of course, will not be cheap, but this topical problem must be solved. We are fulfilling our soldier's duty under far from normal conditions, and we will fulfill it regardless of all difficulties. But the designers also have a duty to the fliers. Isn't it time to give what is due? After all, one good turn deserves another.

Air Forces IAS Officer Responds to Complaints on Loading Equipment

91SV0014I Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 36-37

[Commentary by Colonel V. Grishko, a representative of the Air Forces IAS [Aviation Engineering Service], on the article "How Do We Prepare for Battle?"]

[Text] The problem raised by Senior Lieutenant G. Mamontov is extremely topical. The technological processes in the preparation of aircraft ordnance for use and its loading on contemporary aircraft are most labor-intensive and prolonged. The mechanization equipment that is supplied by the enterprises of industry for this purpose, by and large developed in the 1950s and 1960s, is functionally obsolete, has poor productivity and does not support the execution of the essential set of operations, due to which the share of manual labor among IAS [aviation engineering service] specialists totals about 80 percent.

Research conducted by the Air Forces Scientific-Research Institute for the Operation and Repair of Aviation Equipment, with the participation of line units, has shown that the prevailing situation is a result of the fact that the OKBs [design bureaus] and enterprises of the industry have not provided a comprehensive solution to the problem of the combat loading of aircraft; that is, mechanization has not encompassed the whole set of ASP operations, from the ordnance dump to loading the aircraft. The development of mechanization equipment was conducted without regard for its mutual ties with ASP across types of operations, or the actual operational and tactical conditions of the activity of Air Forces units.

The NII MO has worked out the look of a three-level system for fitting aircraft with ASP bomb loads according to the results of research that includes groups of motorized, mechanical and manual mechanization equipment, and has developed the principles for the formation of the types and composition of the systems of mechanization equipment and the technical tactical requirements for them. The proposed set of equipment, in the evaluation of specialists, will make it possible to reduce considerably the labor-intensiveness and time periods for the preparation of ASP bomb loads for use and the loading of them onto aircraft, as well as to increase the number of aircraft sorties when performing combat-training missions.

An exhibition of mechanization equipment for labor-intensive processes in preparing aviation equipment and aviation ordnance that has been developed for use in Air Forces units and at enterprises in industry was held at the NII MO base, and decisions were made regarding the development, testing and manufacture of the essential equipment according to the results of it.

It is, however, too soon to say that the problem is close to being solved. The principal efforts in the creation of the essential equipment are still being made not by the producers of the aviation equipment, who are obligated to ensure its complete conformity to operational tactical requirements, but rather by the scientific-research institutes, higher educational institutions, military units and the aircraft-repair facilities of the Air Forces. The list of equipment subject to development and manufacture does not include the many interesting and useful adaptations proposed by aviation personnel. Orders for prototypes of the mechanization equipment, plans for the manufacture of which were approved at the highest levels, are moreover very difficult to place at the industrial enterprises due to the lack of specialized plants and divisions among agencies. Matters have thus moved from a "standstill," but they have not moved as far as is needed to raise the combat readiness of the units and improve the working conditions of the aviation specialists.

The provision of the aviation personnel with modern mechanization equipment should become the common cause of the customers, developers and military units. The attitude toward the problem must be radically altered, the efforts being applied increased and the division of the constituent parts of aviation complexes into important and secondary stopped. And that, in my opinion, will be possible only when aviation systems are accepted for state and military testing only with the full set of equipment for technical support, protection of the personnel and other such so-called "trifles."

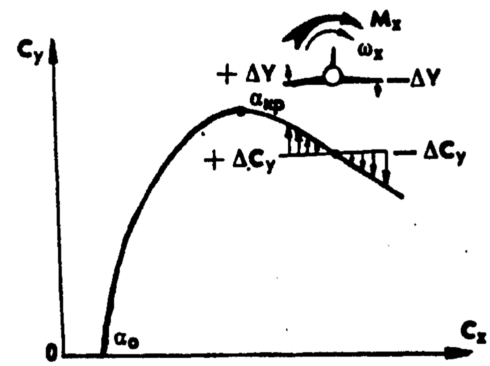


Fig. 1. Cause of the appearance of moments provoking roll

Physics of Spin, Lift Debated

91SV0014J Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 38-39

[Unattributed article under the rubric "Aviation Practicum": "Is Aircraft Spin Theory Correct?"]

[Text] The cause of a spin is explained by the autorotation (windmilling) of the wing at stalling angles of attack. The mechanism by which it arises as it is presented to pilots and cadets is shown in Figs. 1 and 2.

The angle of attack increases on the descending wing in the process of rotation of the aircraft, which leads to a

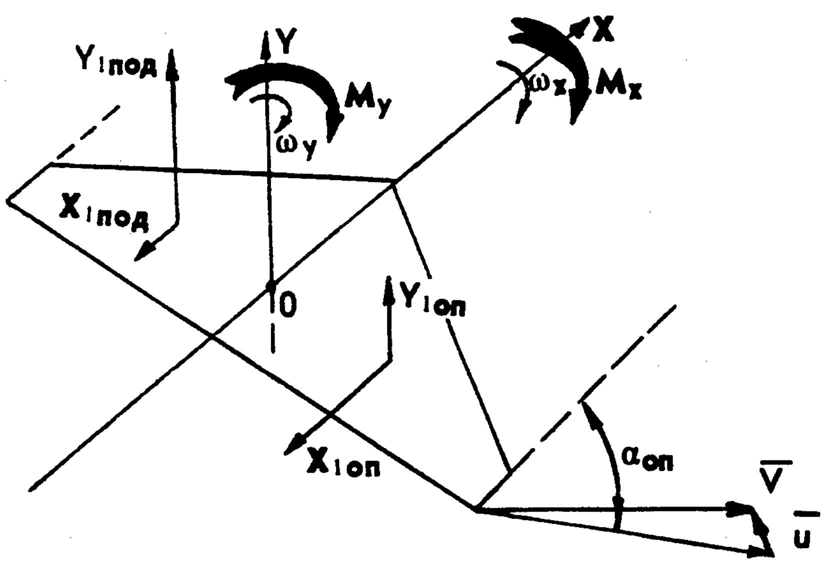


Fig. 2. Autorotation of wing at stalling angles of attack

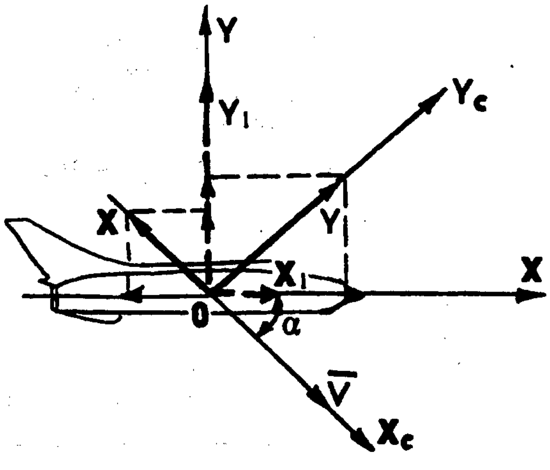


Fig. 3. Ratio of aerodynamic forces in linked and velocity coordinate systems

decrease in lift on it and an increase in drag, with the converse on the ascending wing. This is the essence of the moments that provoke the windmilling of the airframe around its own axes—the axes of a linked system of coordinates. The coefficients of lift and drag are, at the same time, considered in a velocity system (a drag polar of the first type).

The position of these systems of coordinates differs from each other by the magnitude of the angles of attack and sideslip, and coincide only at their zero values. For a spin, where the angles of attack can reach 60-90°, the difference between the forces in these systems becomes considerable (Fig. 3), and the explanation for the autorotation of the wing that is set forth proves to be incorrect.

Why then is this theory of the spin widely employed in training flight personnel? The textbooks for pilots, after all, are written by recognized theoreticians.

Answer to the question: "Lift. Just Where is it Directed?" (AVIATSIYA I KOSMONAVTIKA, 1990, No. 7)

The materials published under the rubric "Aviation Practicum" are eliciting a positive response from readers. They are being regarded as the start of a review of individual long-held provisions of the aviation sciences and their practical application.

The increasing complexity of modern aircraft technology requires changes in the focus of theoretical knowledge of pilots. Instruction in the theory of aerodynamics and the dynamics of flight, however, continues to have no regard for the practices of controlling an airframe or its design engineering, which evokes legitimate protests on the part of those studying it. It is, in fact, difficult not to agree with their opinion; why does an experienced pilot have to know thoroughly the essence of most complex questions of stability and control if an aircraft that is good in that regard has been created for him and he has mastered it fully? The curriculum and textbooks in aerodynamics and the dynamics of flight for flight personnel do not withstand criticism from that standpoint. The rubric we have instituted is also aimed at filling in the mistakes made in them.

The first question to the "Aviation Practicum" was, "Lift. Just Where is it Directed?" Recall that completely opposite conclusions can be obtained under the theory of the appearance of lift that is intended for instructing flight personnel. The scientists are silent on this score. Here is how Private R. Fedkin, a graduate of the SPTU [Agricultural Vocational-Technical School] No. 89 of the MAI [Moscow Aviation Institute] KTTM looks at this problem:

"The method of explaining the reasons for the appearance of lift on an aircraft wing based on the use of just two laws (Bernoulli and constant air flow) cannot make any claim to priority. And that is, first and foremost, because it does not take into account a number of other material factors. I feel that it is necessary to have just as cautious an attitude toward approximate general conclusions in this science as toward rough and round values of figures in physics and mathematics. This is often understandable only to a narrow circle of people.

"The lift Y on an aircraft wing depends on its geometric shape and parameters and the state of the atmosphere, as well as the flight mode as defined by the angle of attack, altitude and Mach number. Y is consequently an aggregate of the manifestation of many factors joined into an overall picture of the flow around the aircraft. It is determined by the mass of the onrushing air flow driven downward by the wing per unit time.

"One consequence of the law of continuity, as well as the powerful leading-edge force in the region of rarefaction, is the fact that the airflow passing over a plane is also slanted below. The laws of constant air flow and Bernoulli remain in force, making possible the appearance of compressibility, viscosity of the air and effects on the airflow pattern around the aircraft.

"The change in the amount of movement per unit time is equal to the effective force F:

$$F = mv = \mathrm{Y},$$

where m is the mass per second of the air and v is the velocity increment of the airflow on the vertical (acceleration) as the result of interaction with the wing. The lift is thus equal to the per-second increase in the quantity of air movement in the direction perpendicular to the movement of the wing, while the ratio of the forward speed and that perpendicular to it will define the angle of wash. The greater that angle, with all other things being equal, the higher the value of Y.

"Initially, under conditions of a continuous flow, the lift increases in linear dependence to increases in the angle of attack. From the moment of the start of a break in the airflow on the upper surface of the wing due to a reduction in the contribution of rarefaction in the wash

of the air mass, the increase in Y slows, and after the critical angle of attack it begins to decrease altogether. The overall lift depends not on the partial difference of the pressure "over and under the wing," but on the sum of the vectors of the pressures concurrent with each point on its skin. It would be more precise if this were considered in relation to the surface of the entire aircraft.

"I have thus tried to present only a physical picture of the appearance of lift on an airframe, which should undoubtedly precede a profound study of this issue. There are other explanations as well, including using mathematics. These could include the theory of lift on a wing developed by Professor N.Ye. Zhukovskiy in his work 'On Adjacent Vortices,' published back in 1906."

What do others think?

Cryogenic Engines Enhance Performance of Buran Spacecraft

91SV0014K Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 91 (signed to press 24 Jan 91) pp 44-45

[Article by Doctor of Technical Sciences B. Sokolov, deputy chief designer of the Energiya NPO [Scientific Production Association], and Candidate of Technical Sciences A. Sanin: "Cold and Flame in the Same Harness"]

[Text] The authors of the article "First Flight" (AVIATSIYA I KOSMONAVTIKA, 1989, No. 4), V. Kravets and O. Babkov, describing the combined power plant (CPP) of the Buran orbital spacecraft, write that it includes 48 engines in three different thrust sizes. The complexity and novelty of the CPP, however, are determined not so much by the quantity of engines and diversity of the tasks being resolved with their help as they are by the new engineering solutions that were necessitated by the choice of the fuel pairing of liquid oxygen and hydrocarbon fuel.

Even today, half a decade later, this choice does not seem indisputable to many specialists. The point is that the use of a cryogenic fuel component such as liquid oxygen for engine systems of this type entails the solution of a host of engineering problems. Power plants for orbital space systems in world practice up to the present time, after all, have been created exclusively using non-cryogenic fuels with either single-component (hydrazine, hydrogen peroxide) or dual-component (oxidizer of nitrogen tetroxide, fuel of derivatives of hydrazine) fuels. Almost all of those substances (aside from the hydrogen peroxide) are highly toxic, and some of the hydrazine derivatives are ecologically hazardous as well.

The use of an oxygen-hydrocarbon fuel has made it possible to increase considerably the power-to-weight ratio of the Buran, and to make its operation safer and more ecologically clean. This is especially important for reusable space-transport systems. The opportunity has appeared of combining the CPP with other on-board systems of the Buran that use oxygen, for example electric-power supply and life support.

The technical distinctiveness of the installation is largely determined by the enhanced requirements for safety and reliability, the support of reusability and escape from non-standard situations, among others. The effect of the fuel mass on the center of gravity of the Buran as a winged airframe also has an impact on its technical aspects as well. It is thus not surprising that the creation of the CPP proved to be a very complex affair, and required a great deal of effort from the designers, production workers and testers.

We will present several figures in addition to those that were already given in the aforementioned article, in order to give the reader a more complete representation of the capabilities of the Buran. The thrust of each of the two engines for orbital maneuvering is 90 kN, their empty specific thrust impulse is 362 seconds and the number of firings per flight is up to 15. Each of the 38 control engines has a thrust of four kN, a specific thrust impulse of 275-295 seconds and up to 2,000 firings per flight. They not only control the position, but also support the movement of the center of mass of the orbital vessel in space. The precision-orientation installations (eight of them), each with a thrust of 200 N, only maintain it in a certain position.

All the operations in the refueling and storage of the fuel components, monitoring of their state, control of the flows of liquids and gases and switching on and switching off are performed by elements of the pneumatic-hydraulic system, as well as the instruments and sensors of the control and measurement system. Their combination into design elements eased the conditions for CPP installation and operation.

The use of a cryogenic oxidizer in an installation with a large number of control engines that are significantly removed from the fuel tanks and designed for a duration of orbital flight of up to 30 days required the solution of two exceedingly complex problems—providing for the long-term storage of liquid oxygen in the tank with the presence of heat influx from without, and maintaining the constant presence of the oxidizer (with the corresponding parameters) at the control-engine intake for the purpose of switching it on at any moment in the flight.

The first task was resolved through the deep cooling (to -210°C) of the oxygen and its refueling in a unified heat-insulated tank that is equipped with mixing apparatus to equalize the temperature in flight. The whole store of oxygen intended both for the principal (cruising) and the control engines is kept in this state. All of this makes it possible to avoid losses over the span of 15-20 days; longer flights will be supported using cooling machinery.

A non-traditional solution was found for the second task. The feed of the control engines is accomplished using gaseous oxygen obtained from a special on-board gasifier via the combustion of a small amount of the fuel in the liquid oxygen.

Now a few words about other solutions that distinguish the CPP of the Buran from existing ones. They include the use of electrical ignition in the control engines, cooling with gaseous oxygen and the use of capillary-tube intake devices. The presence of a powerful cruising engine today makes it possible to perform the accelerated use of fuel in non-standard situations and, in the future, to raise the overall efficiency of the Buran—Energiya system through the inclusion of those engines in the active section.

How does the CPP operate? Recall that the working medium of the pneumatic-hydraulic control system is helium, which is stored in spherical tanks submerged in the liquid oxygen. The sequence and logic of system operation are determined by the program and algorithms in the on-board computer and instruments of the control and technical-diagnostics systems.

A preliminary axial G-force equal to 0.001 of the Earth's is created with the aid of two controllers for 20-25 seconds before the ignition of the cruising engine. The liquids in the fuel tanks move toward the outlet valves under the effects of it, and are drawn by the preliminary booster pumps located directly on the tanks.

The fuel tanks are filled with helium during the process of operation of the cruising engine, and it is heated in a heat regenerator before being fed into the fuel tank. As soon as an assigned thrust impulse is issued, it is turned off, the gate valves are closed and the supercharging is halted.

The control engines are fed with an oxidizer from the receivers, which contain gasified oxygen under 2.5-5.0 MPa of pressure. It has enough reserves in store for the operation of ten of these engines for two or three seconds. When the pressure in the receivers drops to 3.0-2.5 MPa, one or two oxidizer gasifiers are turned on by command of the corresponding signal device.

The fuel for the control engines is fed in from the auxiliary high-pressure fuel tanks that are equipped with a baffle membrane. Their refueling from the main tank is provided for using a special pump.

If the failure of one of the engines of the Energiya launch vehicle occurred during the launch process and the return of the Buran to the airfield near the launch complex had to be realized, the principal task of the CPP becomes the intensive burning and dumping of fuel from the tanks in order to provide for the necessary center of gravity by the moment of separation from the launch vehicle. The simultaneous ignition of both cruising engines, as well as the discharge of the gaseous oxygen through special pipes, is envisaged for that purpose. They will continue to operate after the emergency separation of the Buran from the launch vehicle until the fuel is completely consumed.

The operational reliability of the installation is achieved through redundancy in its vitally important elements, combined with the possibility of disconnecting elements that fail and turning on back-ups. These operations are performed by the CPP's functional system for monitoring, diagnostics and emergency protection. It is based on on-board equipment operating in automatic mode, which also makes it possible for both the crew and the ground-control complex to perform protective operations. The on-board portion of the system includes about 100 sensors of various types (pressure, pressure drops, temperatures, vibrations, movements) and just as many pneumatic relays, as well as computer devices and CPP control elements for emergency situations.

Fast-developing, and therefore especially dangerous, failures of the "rotor-fire" assemblies (in the cruising engines and gasifiers) are monitored by special computer devices—emergency-protection modules. The dangerous consequences of failures connected with flaws in the turbopump rotor are anticipated via monitoring of the constituents of the vibration-overload spectrum.

Failures develop to dangerous levels in other CPP systems, after their detection, over a time period sufficient to monitor, diagnose and take emergency steps using the central computer system of the Buran (no less than 0.03 seconds). The principal tasks in such cases is the search for and elimination of various leaks that could, over a prolonged flight, lead to loss of the working medium.

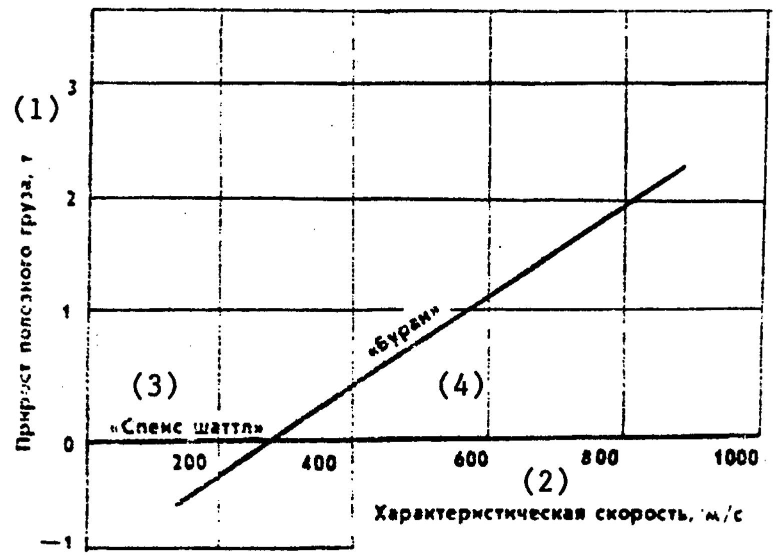
Especial attention in the development of the monitoring, diagnostics and emergency-protection system was devoted to the issue of false commands and information.

The Buran CPP is the first installation of a new class using non-toxic cryogenic fuels. Its technical level can be assessed just via a comparison with a functional analogue—the auxiliary installation of the Space Shuttle spacecraft. The indicators for the Buran CPP are markedly higher than the American model in the thrust of the cruising engines (more than triple) and in their specific impulse (by more than 50 seconds). The "cost" of those advantages (including the non-toxicity of the fuel) is the complexity of the CPP pneumatic-hydraulic system and, as a consequence, an increased design mass compared to the shuttle—by roughly 1,100 kilograms.

It can be seen from the chart that the use of the cryogenic CPP provides an overall gain in payload mass across the broad spectrum of velocity parameters (from 300 meters/second and up) typical of the majority of practical tasks of the Buran and Space Shuttle orbital spacecraft.

And another thing. The "value" of the specific thrust impulse increases with the increase in the velocity parameters, and the increased power reserves (total thrust impulse) contained in the principal refueling of the Buran CPP also has an effect. The possibility of combining the CPP with a system of electric-power supply for oxygen also plays no small positive role.

The first step has thus been taken. Ahead lie the new flights on which the Buran orbital spacecraft will be



Key:
1. Increase in payload, tons
2. Velocity parameters, meters/second
3. Space Shuttle
4. Buran

brought by the cryogenic CPP, uniting within itself the outer-space coldness of liquid oxygen with the flame of rocket engines.

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